Institute of Water Research
Annual Technical Report
FY 2016

Introduction

The Institute of Water Research (IWR) at Michigan State University (MSU) continuously provides timely information for addressing contemporary land and water resource issues through coordinated multidisciplinary efforts using advanced information and networking systems. The IWR endeavors to strengthen MSU's efforts in nontraditional education, outreach, and interdisciplinary studies utilizing available advanced technology, and partnerships with local, state, regional, and federal organizations and individuals. Activities include coordinating education and training programs on surface and ground water protection, land use and watershed management, and many others. We also encourage accessing our web site which offers a more comprehensive resource on IWR activities, goals, and accomplishments: http://www.iwr.msu.edu

The IWR has increasingly recognized the acute need and effort for multi-disciplinary research to achieve better water management and improved water quality. This effort involves the integration of research, data, and knowledge with the application of models and geographic information systems (GIS) to produce spatial decision support systems (SDSS). These geospatial decision support systems provide an analytical framework and research data via the web to assist individuals and local and state government agencies make wise resource decisions. The IWR has also increasingly become a catalyst for region wide decision-making support in partnership with other states in EPA Region 5 using state-of-the-art decision support systems.

The IWR works with MSUs AgBio Research and closely with the Cooperative Extension Service to conduct outreach and education. Outreach activities are detailed in the Information Dissemination section of this report. USGS support of this Institute as well as others in the region enhances the IWR credibility and facilitates partnerships with other federal agencies, universities, and local and state government agencies. The IWR also provides important support to MSU-WATER, a major university initiative dealing with urban storm water issues with funding from the university Vice President for Finance. A member of the IWR's staff works half-time in facilitating MSU-WATER activities so the IWR enjoys a close linkage with this project. The following provides a more detailed explanation of the IWR's general philosophy and approach in defining its program areas and responsibilities.

General Statement

To deal successfully with the emergence of water resource issues unique to the 21st century, transformation of our knowledge and understanding of water for the protection, conservation, and management of water resources is imperative. Radically innovative approaches involving our best scientific knowledge, extensive spatial databases, and "intelligent" tools that visualize wise resource management and conservation in a single holistic system are likewise imperative. Finally, holistic system analysis and understanding requires a strong and integrated multi-disciplinary framework.

Research Program Introduction

The management of water resources, appropriate policies, and data acquisition and modeling continue to be at the forefront of the State, Regional, and National Legislatures agenda and numerous environmental and agricultural organizations. Our contribution to informing the debate involved numerous meetings, personal discussions, and most importantly, the enhancement of web-based information to aid in the informed decision-making process.

Unique Capabilities: Decision Support Systems as the Nexus IWR, with its “extended research family,” is exceptionally well-positioned to integrate research conducted within each of the three principal water research domains: hydrologic sciences, water policy, and aquatic ecosystems. Integrated decision support both reflects and forms the nexus of these three research domains. Expanding web accessibility to the decision support system nexus (formed by the intersection of the three research domains) will facilitate broad distribution of science-based research produced in these domains. A special emphasis is being placed on facilitation of science-based natural resource state and national policy evolution. Fundamentally we are addressing the Coupled Human and Natural System (CHANS).

The IWR’s extensive experience in regional and national networking provides exceptional opportunities for assembling multi-agency funding to support interdisciplinary water research projects and multi-university partnerships.

Using a multi-disciplinary framework facilitates dynamic applications of information to create geospatial, place-based strategies, including watershed management tools, to optimize economic benefits and assure long-term sustainability of valuable water resources. New information technologies including GIS and computational analysis, enhanced human/machine interfaces that drive better information distribution, and access to extensive real-time environmental datasets make a new “intelligent reality” possible. This is our way of addressing the "CHANS."

Effective watershed management requires integration of theory, data, simulation models, and expert judgment to solve practical problems. Geospatial decision support systems meet these requirements with the capacity to assess and present information geographically, or spatially, through an interface with a geographic information system (GIS). Through the integration of databases, simulation models, and user interfaces, these systems are designed to assist decision makers in evaluating the economic and environmental impacts of various watershed management alternatives.

The ultimate goal of these new imperatives is to guide sustainable water use plus secure and protect the future of water quality and supplies in the Great Lakes Basin, across the country and the world—with management strategies based on an understanding of the uniqueness of each watershed.

IWR Advisory Team The Water Resources Research Act supports the development of an Advisory Committee that has broad representation for each of the 54 Water Institutes located at Land-Grant Universities.

The IWR at Michigan State University (MSU) has assembled an Advisory Team consisting of five key individuals each with major responsibilities in different realms of water research, management and outreach education assuring a wide diversity of perspectives. The characteristics of the team incorporate a vision of future needs, technologies, and approaches that the IWR should consider including into our present and future planning and strategies.

Specific responsibilities include: (1) provide informative and broad guidance/direction for the director and personnel of IWR for the present and future; (2) provide guidance for IWR operations; (3) advise on diffusion and linkages of research, information technologies, and their use in operationalizing IWR activities; (4) serve as an important interface with AgBio Research, MSU Extension, and the University.

The Advisory Team will meet three times per year. On an ongoing basis, key IWR activities and planning will be provided to the Advisory Team and they will assist the IWR in its mission to assure a continued high level of productivity, creativity, and impact.

Advisory Team Members

Mr. Jon Allan, Director, Office of the Great Lakes Michigan Department of Environmental Quality Mr. Scott Piggott, Chief Operating Officer Michigan Farm Bureau Dr. Pat Doran, Associate State Director/Conservation Director for Michigan The Nature Conservancy, Michigan

Ms. Lisa Brush, Executive Director Stewardship Network, Michigan

Dr. Michael Jones, Assistant Director of Natural Resources Programs AgBio Research, and Professor, Department of Fisheries & Wildlife Michigan State University

Developing and Enhancing Sustainable Water Use of Natural and Agricultural Systems

Basic Information

Title:	Developing and Enhancing Sustainable Water Use of Natural and Agricultural Systems
Project Number:	2016MI236B
Start Date:	3/1/2016
End Date:	2/28/2017
Funding Source:	104B
Congressional District:	8
Research Category:	Climate and Hydrologic Processes
Focus Categories:	Management and Planning, Water Quality, Water Quantity
Descriptors:	None
Principal Investigators:	Jon Bartholic, Lois Wolfson, Jeremiah A Asher, David Lusch, Glenn A O'Neil

Publications

1. Young, L., K. Freestone and R. Breen. 2017. Improving Collaboration with the Great Lakes Clean Communities Network. January 11. Webinar.
2. Young, L. and J. Piwarski. 2017. Michigan Sensitive Areas Identification System: Helping Farmers Connect with Conservation Professionals. The Science, Practice & Art of Restoring Native Ecosystems Conference. January 12. East Lansing, MI.
3. Young, L. and L. Wolfson. 2017. The Great Lakes Clean Communities Network. Michigan State University Extension Online Course Development. February 13. Webinar.
4. Young, L. 2016. Michigan Sensitive Areas Identification System. Soil Water Conservation Society Workshop at the Michigan Association of Conservation Districts Conference. October 24. Bellaire, MI.
5. Wolfson, L. and L. Young. 2016. The Great Lakes Clean Communities Network: Connect to Protect. Michigan Inland Lakes Convention. April 29. Boyne Falls, MI.
6. Young, L, L. Wolfson, J. Asher, K. Freestone, J. Piwarski, S. Petit, C. Lampe, and J. Bartholic. 2016. The Great Lakes Clean Communities Network: Promoting Collaboration and Innovation in the Great Lakes (poster). The Science, Practice & Art of Restoring Native Ecosystems Conference. January 15. East Lansing, MI.
7. Young, L., J. Piwarski and B. Dierberger. 2016. Sensitive Areas Identification System Webinar. September 22.
8. Young, L., J. Piwarski and B. Dierberger. 2016. Sensitive Areas Identification System Training Workshop. August 4. Adrian, MI.
9. Young, L. 2016. Sensitive Areas Identification System Training Quick Guide Materials.
10. Young, L. 2016. Go Green Help Keep Our Water Clean. Flint River GREEN Student Summit. May 20. Flint, MI. Asher, J. 2016. Technology for Sustainable Farming. Technological and Innovative Selection of Conervation Practices. Michigan Association of Conservation Districts Fall Conference
11. Asher, J. 2016. Improving Ecological Health in Your Community Using the Ecological Scorecard Framework. Great Lakes Clean Communities Webinar Series.
12. Asher, J. 2016. In-ditch Wetland Treatment of Phosphorus in Tile Drains. U.S. Army Corps of Engineers Sediment Workshop.

13. Asher, J. 2016 Groundwater Credit Trading Workshop. Michigan Farm Bureau and Cass County Farmers.

Objectives

(1) IWR continues its restructuring to more effectively link knowledge with action, i.e., connecting knowledge generation and local applications by becoming an appropriately structured boundary organization.
(2) Continues its active involvement in leading, demonstrating and evaluating the process through numerous specific activities involving "wicked" problems.
(3) Enhance current and develop new decision support systems that provide support for knowledge users to make more informed decisions based on input from the knowledge generators.
(4) Augment development of this new bridging structure through an external advisory body, representing a cross-section of users and scientific groups.
(5) Enrich the evolving inclusive environment to facilitate a sense of trust among the knowledge users so they can effectively interact with the knowledge generators, creating an atmosphere and functionality where there is successful communication, translation, mediation, and adaptive process outcomes.
(6) Continue to actively inform and partner with NGOs and other funding agencies to aid in acquiring support of IWR activities. These partnerships help to add new funding sources to IWR's existing broad portfolio of funders to facilitate an expanding base of fiscal support.

Methodology

Research Methods/Experimental Procedures

The manner in which we have engaged in team efforts with the scientific community from across campus, the state and region has been effective and provides an approach upon which we can build. As previously mentioned, we have an evolving process which will help us to transform IWR to more effectively address "wicked" problems. The advisory body, previously described, will be critical in guiding the re-creation of IWR activities, which will lead to more holistic and effective approaches for addressing "wicked" problems. These various inputs will guide our initial activities. In addition to its staff members who have expertise in a broad array of water resource management topics, including database development and information systems, GIS, aquatic ecology and community-based water management programming, IWR has historically worked with many diverse faculty members representing a broad cross section of water resource expertise across MSU colleges. A listing of the faculty members and students who have recently worked with and received support from IWR on various water resource management projects was included in a recent report compiled for the Water Resources Partnership, a jointly funded agreement with the Michigan Department of Environmental Quality and MSU.

Our first achievement strategy is to build on and transform current IWR strengths, partnerships,

and reputation. By working in a co-creative framework with individuals, policymakers and organizations to integrate the science and knowledge base, IWR is generating adaptive and

dynamic systems for management of critical water resources that includes ecological, social and economic components.

(1) Reorganize IWR to more effectively link knowledge with action, i.e., connecting knowledge generation and local applications by becoming an appropriately structured boundary organization. The structure depicted in Figure 1 shows that IWR will not only serve as a critical link between the research and knowledge generated by the scientific community (i.e., entities at the University) and the user community, but will also serve to facilitate the co-creation of knowledge (middle column, Figure 1) by working with the end users (right column) and the scientific community (left column).

(2) Actively be involved in facilitating, leading, demonstrating and evaluating the co- creation process through numerous specific activities involving "wicked" problems. Water resource management with consideration for economic development is a complex problem because it often demands organizations/stakeholders at all levels to come together and find acceptable solutions to issues. Such solutions may also evolve over time when agreed upon by the parties involved. Integrating sciences into this dynamic social process and utilize modern technologies to facilitate communications and problem solving is the grand challenge we face as university researchers and technology transfer professionals. As a boundary organization, our objective is to be uniquely positioned to work across disciplinary boundaries and bring advanced sciences and technologies into decision makers' hands. Since there is a large gap between academic research and real world operational applications, bridging this gap and streamlining research and the technology transfer process is a major task for IWR . The efficient and effective utilization of modern technologies such as advanced Information and Communication Technology (ICT), GIS and numerical modeling is the key to achieve this objective.

(3) Develop decision support systems that provide support for knowledge users to make more informed decisions based on input from the knowledge generators. As we move from the traditional PC-based computing era to a new Internet-based cloud computing age with millions of mobile computing devices coming online at an accelerated rate, we have tapped into developing a new generation of water resource decision support and knowledge systems that can take advantage of recent advances in cyber infrastructure, social networking, geospatial technologies and numerical modeling and associated scientific visualization technologies. To implement this new generation of systems, we must analyze the needs of different target audiences such as federal, state and local government agencies, NGOs, various environmental organizations and the general public. It is critically important that we bring environmental knowledge producers and consumers together under the same overarching umbrella and provide tools for them to work together in a mutually beneficial manner. We need to understand their needs and concerns and address them appropriately.

(4) Guide development of this new bridging structure through an external advisory body, representing a cross-section of users and scientific groups. This advisory body will have integrative and dynamic roles in providing

guidance and ideas to communities of users. The scientists involved will provide connections to clusters of water expertise from the following: multiple units within CANR, such as the Center for Water Sciences and Department of Biosystems and Ag Engineering; other colleges, such as Natural Science

and Civil and Environmental Engineering; and, external partners including the USGS Great Lakes Science Center, The Nature Conservancy and others.

(5) Provide an inclusive environment to facilitate a sense of trust among the knowledge users so they can effectively interact with the knowledge generators, creating an atmosphere and functionality where there is successful communication, translation, mediation, and adaptive process outcomes.

(6) Actively inform and partner with NGOs (with emphasis on TNC) and other funding agencies such as EPA, GLPF (Great Lakes Protection Fund), US Army Corps of Engineers, etc., to aid in acquiring support of IWR activities. These partnerships will help to add new funding sources to IWR's existing broad portfolio of funders to facilitate an expanding base of fiscal support.

Literature Review

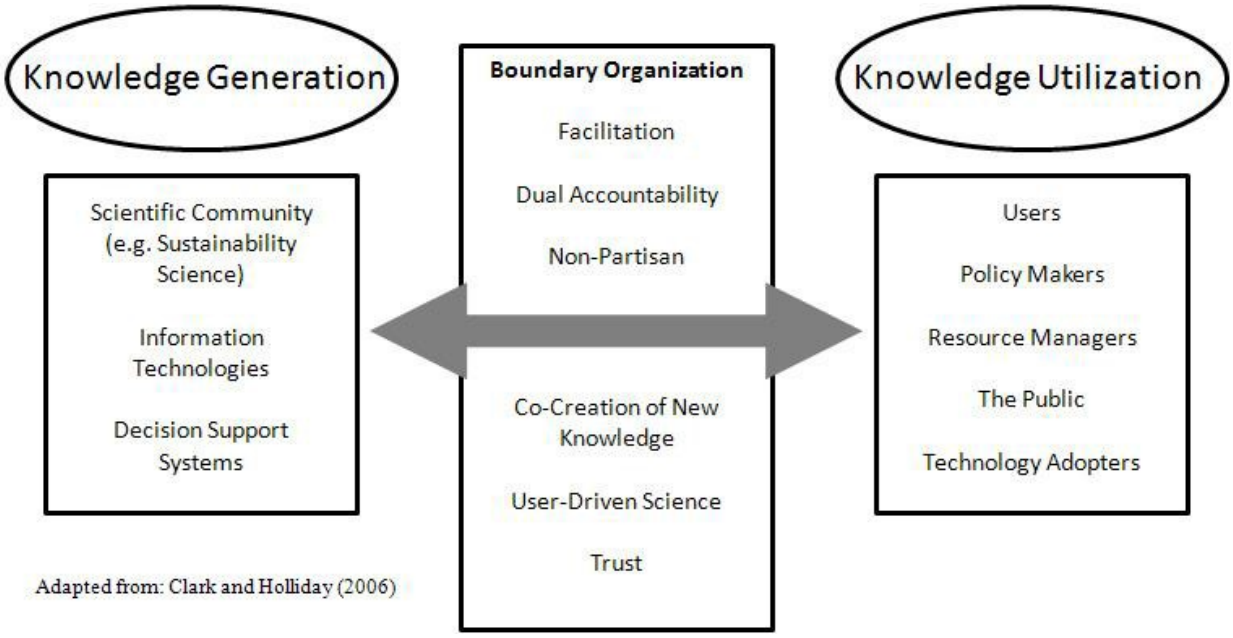

Figure 1. Boundary organization: Linking knowledge with action

All social, economic and environmental factors in a watershed need to be considered in a holistic approach to determine proper actions to manage water resources (Heathcote 1998; Gregersen et al., 2008). Watershed management often involves multiple stakeholders with conflicting interests. These stakeholders can have radically different perceptions of the problems and potential trade-offs associated with finding solutions because of dynamic social, economic, and political factors as

well as biophysical complexities of water resource issues.
This complex nature of water resource management and other related issues, such as global climate change or health issues, is often referred to in the scientific community as wicked problems (Batie, 2008). These types of problems are so named because they are usually difficult to solve due to their complexities and changing nature and often may create other problems as the initial ones are being addressed.

Research on wicked-type problems suggests that a comprehensive knowledge system sustained by a boundary organization is essential (Cash et al., 2003). Boundary organizations act as intermediaries between science and policy because they fulfill or possess: 1) specialized roles within the organization for managing the boundary; 2) clear lines of responsibility and accountability to distinct social arenas on opposite sides of the boundary; and 3) a forum in which information can be co-created by interested parties (Cash et al., 2003). Ingram and Bradley (2006) define boundary organizations as those situated between different social and organizational worlds, such as science and policy. Guston (2001) list three conditions often attributed to successful boundary organizations. "First, they must provide incentives to produce boundary objects, such as decisions or products that reflect the input of different perspectives. Second, they involve participation from actors across boundaries. Third, they have lines of accountability to the various organizations spanned by the boundary organization." According to Batie (2008), adaptive and inclusive management practices are essential to the functioning of boundary organizations, and Ruttan et al. (1991) suggests that boundary organizations serve as a bridging institution and help to link suppliers and users of knowledge.

One way to further the efforts of boundary organizations, particularly with wicked problems, is to provide tools to assist with good decision-making using science-based data. Spatial Decision Support Systems (SDSS) are a type of computer system that combine the technologies of Geographic Information Systems (GIS) and DSS to assist decision-makers with problems that have spatial dimensions (Walsh 1993). SDSS are developed to integrate data, knowledge, and modeling results to identify, evaluate, and recommend alternative solutions to spatially distributed problems (Djokic, 1996; Prato and Hajkowicz, 1999). A SDSS focuses on a limited problem domain, utilizes a variety of data, and brings analytical and statistical modeling capabilities to solve the problems. It further depends on graphical displays to convey information to the users. It can be adapted to decision-maker's style of problem solving, and can easily be extended to include new capabilities as needed (Densham et al. 1989, Armstrong et al. 1990).

In natural resource management, SDSS have proven to be effective in a variety of applications such as flood prediction (Al-Sabhan et al., 2003) and conservation program management and best management practices assessment (Rao et al., 2007). Al-Sabhan et al. (2003) argued that a web-based hydrologic modeling SDSS can help solve problems such as limited accessibility by non-experts and the public; lack of collaboration support; and costly data acquisition and communications. They further

indicated such system can offer openness, user friendly interface, transparency, interactivity, flexibility, and fast communication and be directly accessible to a broad audience including decision makers, stakeholders and the general public.

Principal Findings and Significance

Previous Work and Present Outlook

- Broad Guidance: Impact Support
- Research Projects
- Spatial Decision Support Systems (SDSS)
- Building a Great Lakes Basin-Wide IT/Decision Support/Networking System

Broad Guidance: Impact Support

To guide our discovery, integrative activities and outreach, we actively and continually interact with numerous diverse organizations, government agencies, and individuals.

Water Use Advisory Council Support

The Michigan Department of Environmental Quality (MDEQ) convened the Water Use Advisory Council, made up of roughly 30 members, for a two-year appointment in early 2013 to advise MDEQ Director Dan Wyant on Michigan's Water Use Program. The Council concluded its work in December of 2014. A final report consisting of 69 recommendations was submitted to Director Wyant. Diverse interests were represented on the Council, including those from government, non-profit organizations, and those representing agricultural, industrial, commercial, or environmental interests. The MSU-IWR had ex-officio membership on the Council and Frank Ruswick served as a co-chair of the Water Conservation and Use Efficiency work group.

Being intimately involved with Council activities allowed the IWR to understand emerging needs relating to water use within the state and directly align certain project activities with major issues identified through the Council. Discussions continue through the advisory council and provide the IWR with opportunities to enhance the Water Withdrawal Assessment Tool.

The IWR prepared a white paper for inclusion in the Michigan Water Strategy regarding wise use of Michigan's water cycle and resources. A main goal covered in the paper emphasized that Michigan's water resources need to be maintained with a goal that optimizes community and human health, and natural, recreational, economic, and cultural uses and values. Addressing this goal requires a water resource perspective that begins with an overview and understanding of Michigan's water cycle and how its components interact. We are now involved in the early stages of the refining and implementation of the States' Water Strategy.

White Paper per request of the Michigan Office of the Great Lakes for inclusion in the Michigan Water Strategy: The Status and Future of Water Conservation in Michigan –

Prepared February 2015

A conservation perspective that marries economic drivers and a desire and obligation for care and stewardship should be the foundation for Michigan's water management policy. As the fundamental basis for holding on to water in the Great Lakes, it would place Michigan and the region in a strong position to demand conservation performance by those who may covet the water riches of the Great Lakes. This White Paper examined Michigan's approach to water conservation and stressed that it need not be based on the exigencies of immediate or widespread scarcity. It called for the development of an integrated system of water conservation driven by deep respect and care for water as the basis of life. We are now involved with the co- creation of the Water Conservation Strategy.

Michigan Natural Resources Working Group

Background

The Michigan Natural Resources Working Group (NRWG ~ initiated and facilitated by MSU- IWR) is a partnership of federal, state and local agencies and organizations with an interest in conserving Michigan's natural resources. Partners include the Great Lakes Commission, Michigan Department of Agriculture and Rural Development, Michigan Department of Environmental Quality, Michigan Farm Bureau, The Nature Conservancy, US Geological Survey, USDA Natural Resources Conservation Service, US Fish and Wildlife Service, Shiawassee Conservation District, Lenawee Conservation District and Michigan State University (Institute of Water Research; Department of Sociology; Michigan State Extension; Department of Community Sustainability; Land Policy Institute).

The partners first met in November 2011 and have since been meeting regularly. The goal of the initial meeting was for each member organization to identify challenges and goals that they are currently facing. Two were found in common among all members of the partnership. The first was a need to measure accomplishments in terms of outcomes in addition to outputs (e.g., output of acres under conservation treatment and an outcome based on improvements in fish populations). The second was a need to find more effective ways to get residents to make desired changes (e.g., looking at other approaches besides farm bill programs to encourage farmers to make changes in their farming practices). The partners decided to use a "results chain" approach in order to understand the current strategies that are being used to address natural resource conservation and identify a future direction.

During the past reporting year, the Natural Resources Working Group (NRWG) has continued to serve as a forum for information exchange and collaboration of natural resource related groups and agencies in Michigan. Topics discussed and supported through the NRWG include

- the GLRI project "Cooling the Hot Spots" in the Western Lake Erie Basin
- the Great Lakes Clean Communities Network
- Collective Impacts
- The Nature Conservancy Projects in the Saginaw Bay Area (RCPP, Pay for

Performance, Groundwater Recharge)
- Saginaw Optimization Decision Model
- training on Edge of Field Monitoring for NRCS, Conservation District, State of Michigan, and others

Assessment of Collaborative Capacity
IWR worked with Dr. Stephen Gasteyer (MSU Department of Sociology) to assess the motivations and causal models of NRWG members for participation in periodic

meetings and coordinated actions. The rationale is that this group has the potential to provide coordinated leadership in addressing longstanding problems of surface water quality impairment in key watersheds: River Raisin; Western Lake Erie; Shiawassee/Saginaw Bay.

This research assessed the collaborative capacity of a multi-institutional collaboration to address disproportionality in water quality impairment in Michigan watersheds. The key finding was that 1) there is real interest in collaboration, 2) there is diversity in interest in collaboration, 3) the challenge of maintaining the collaboration will necessitate a continued focus modeling and intensification of voluntary approaches to land management.

Strategic Doing
In order to take action to address our common challenges and goals, the NRWG enlisted the assistance of Robert Brown, Associate Director of University-Community Partnerships, Michigan State University Outreach and Engagement. Mr. Brown led the NRWG through a process based on Strategic Doing. According to the Purdue Center for Regional Development, Strategic Doing is "a set of principles, practices and disciplines for implementing strategy in a network." (Strategic Doing: The Art and Practice of Strategic Action in Open Networks, Staff Publication 2010-1, Ed Morrison, Purdue Center for Regional Development, February 2010). The NRWG started with a framing question: *How do we use our assets and resources to develop innovative ways to change behavior on rural lands within the River Raisin and Shiawassee River watersheds resulting in improved water quality, benefiting human health and fish communities?*

After identifying assets that each member of the NRWG is willing to share, the group developed seven outcomes that should be accomplished together. These include:

1. Develop guiding system for decision making/process
2. Use results chain to determine additional data layers that would be pertinent to this analysis
3. Select, prioritize and depict specific rural geographic areas for action
4. Engage farmers and land owners as partners to change land practices
5. Increase knowledge of available sources of funding for activities at hand
6. Engage stakeholders that can either encourage or inhibit practice change (supply chain stakeholders and policy stakeholders) as partners to change land practices

7. Identify and disseminate existing and new knowledge

Current actions
After completing actions 1 and 2 during the previous year, the NRWG proceeded to complete action number 3 within the Shiawassee and River Raisin watersheds in Michigan in the following months. The geographic units used in the prioritization were watersheds, specifically at the HUC-12 level, and were presented to the group toward the end of 2014.

The NRWG was been able to efficiently work toward completing actions 4 and 5 in the last year as well. While reviewing results of the prioritization analysis, several members of the NRWG realized that these efforts would couple well with a proposed Great Lakes Restoration Initiative project, titled "*Cooling the Hot Spots*." This proposed project involved a pay-for-performance process for reducing phosphorus and the creation of a farmer advisory council in the River Raisin watershed, to engage farmers to join the program and raise awareness about water quality issues within the Western Lake Erie Basin. This grant was awarded by the EPA to the Stewardship Network at the end of 2014 and is currently underway. The MSU-IWR is providing technical and decision support expertise to the *Cooling the Hotspots* project.

Research Projects

The following projects represent activities supported with over $2 million dollars from our partners. USGS 104b projects are covered in other sections of this report. To the maximum extent possible and appropriate, we work on harmonizing project to enhance the coupling of activity pieces on the landscape.

IWR received funding from the Army Corps of Engineers to conduct research on treating phosphorus with in-ditch wetland treatment train. Many conservation practices aimed at reducing excess nutrients from leaving fields only address concerns at the field surface and are unable to address subsurface nutrients that are exiting through the tile drain systems. Some forms of nutrients such as dissolved reactive phosphorus (DRP) pose higher risks as they are more available to plants. This increases the risk for harmful algal bloom formation in places like the Western Lake Erie basin. The in-ditch wetland treatment study will attempt to treat DRP leaving the tile drain with vegetation and phosphorus sorption materials. Construction of the treatment system will begin in 2017.

<u>USDA-NIFA Grant</u>
An Integrative Decision Support System for Managing Water Resources under Increased Climate Variability
The goal of this project is to develop and disseminate a Decision Support System (DSS) that incorporates outputs from a diverse set of hydrologic systems models, analytical tools and processes which examine future climatic scenarios. Using the DSS, policy-makers, water resource managers, and agricultural producers will be able to consider varying climatic conditions while developing sustainable water strategies

within communities and planning for agricultural water uses. Significant components of this project are the assessment of water users to determine and understand their capacity to accept and make behavioral modifications regarding water use as well as the involvement of key individuals and groups that represent the policy-makers, managers and water users during the various stages of the project. Modeling is ongoing during this phase of the project and water user assessments will begin in 2015.

A major outcome of the project will be to assess the implication of these scenarios on Michigan's legislated Water Withdrawal Assessment Tool and process. Furthermore, public engagement and dissemination of the knowledge gained from the project's efforts through enhanced educational programs to be develop and offered by Michigan State University and the expertise provided by Michigan State University Extension.

During 2016, the project team completed the "Water Ways" online interface that allowed farmers, planners, and other users to look at future climate scenarios (2010 to 2110) and predict changes in water budget (stream flow, groundwater recharge, precipitation, and other water related variables) by sub watershed. The tool and report were shared with project stakeholders and made available on the IWR website.

Application of Michigan's legislated Water Withdrawal Assessment Tool (WWAT) and process continues to be a topic of much concern amongst agricultural producers. Through preliminary conversations with WWAT regulators it is hopeful that WaterWay outcomes can be used to help assess the implication of the climate scenarios on the WWAT and process. Also, the knowledge gained from the project's efforts will be disseminated through enhanced educational programs being developed and offered by Michigan State University, with the expertise provided by Michigan State University Extension.

Red Cedar River Watershed

The IWR led the development of a watershed plan for the Red Cedar River Watershed, located in Ingham and Livingston Counties, Michigan. The Red Cedar River Watershed Management Plan (WMP) represents the culmination of a two and a half year collaborative process designed to address existing and potential pollutants in the Red Cedar River. The process included data collection and analysis, an extensive watershed inventory effort and stakeholder involvement. The WMP describes the watershed and water quality issues within it, including the existing TMDLs that have been established for *E. coli* bacteria and dissolved oxygen. Subwatersheds within the Red Cedar are described in detail, and best management practices for addressing nonpoint sources of pollutants within subwatersheds are included as a critical component. The subwatersheds are prioritized using a scoring system to focus implementation activities in the next phase of the watershed planning process.

Regional Conservation Partnership Program (RCPP)

The Regional Conservation Partnership Program (RCPP) is a new program being implemented by the United States Department of Agriculture (USDA) under the 2014 Farm Bill. The RCPP intends to make $1.2 billion in federal funding available over 10 years to address critical conservation concerns across the country. Already, the Saginaw Bay Watershed Conservation Partnership, co-led by The Nature Conservancy and the Michigan Agri-Business Association, is earning national attention and is considered by the USDA, U.S. Secretary of Agriculture Tom Vilsack, and others as a leading candidate to address water quality resource concerns. The Saginaw Bay Watershed Conservation Partnership will provide a total investment of $20 million including $8 million in direct financial assistance and $12 million in technical assistance, to growers in the watershed to implement conservation.

The Saginaw Bay Watershed Conservation Partnership project will utilize the Great Lakes Watershed Management System (GLWMS), a new online tool developed by Michigan State University's Institute of Water Research (MSU-IWR), to model, map, and track implementation progress and water quality benefits. We will use this tool to quantify the annual increase in groundwater recharge (in gallons) and the amount of sediment (in tons) and phosphorus (in

pounds) reduced for each conservation practice implemented. Long-term water quality improvement will ultimately be measured by examining trends in the biological health of riverine systems throughout the watershed. (A portion of this RCPP write-up was secured from the Saginaw Bay Watershed Conservation Partnership TNC fact-sheet.) IWR continues to provide technical support for this project until 2018.

River Raisin Watershed

Several IWR research teams are playing major roles in the Cooling the Hot Spots project, a GLRI collaboration with The Stewardship Network, University of Michigan, Winrock International, MSU Extension, MSU Department of Sociology, Heidelberg University, Adrian College, Michigan Department of Agriculture and Rural Development, River Raisin Watershed Council, and countless other partners. The main objective of this project is developing a pay- for-performance program to incentivize farmers in the Western Lake Erie Basin's River Raisin Watershed in Southeastern Michigan to adopt best management practices on their agricultural land. The goal is a reduction in phosphorus lost in water runoff from farmland, which contributes to the harmful algal blooms (HABs) in Lake Erie.

The IWR has been working with Dr. Stephen Gasteyer in the MSU Department of Sociology to better understand the motivations for farmers to become involved in conservation efforts. In order to study this question, IWR researchers have worked closely with the Farmers Advisory Committee (FAC), a farmer-led watershed group in the River Raisin watershed. The project aims to learn what brings farmers to this group and why they participate. Information was collected through participant observation at field day events and in-depth interviews with FAC participants. In addition, the IWR facilitated a multi-state collaborative workshop on April 8th, 2016 with guest speakers from two successful farmer-led watershed groups, one in Iowa and

the other in Wisconsin. The data will be used to develop surveys that will seek information about farmer opinions on best management practices. Ultimately this section of the project will inform the pay-for-performance program, tailoring the efforts to major motivators for agricultural producers.

In an effort to better understand the health of the River Raisin watershed and to create a baseline for the pay-for-performance program's progress, the IWR has collaborated

with Adrian College, the River Raisin Watershed Council, and the Michigan Agricultural Environmental Assurance Program to form a stream monitoring program. All stream samples are collected by Adrian College students and analyzed in a well-equipped biology lab. This is done under the supervision of Dr. Jim Martin, who is very familiar with the history and landscape of this area. Sampling is currently being conducted at six stream sites and six farm sites throughout the south branch of the River Raisin watershed. Sampling at certain sites has been done since October 2015, and the majority of sites have been sampled since April 2016. Sampling is scheduled to continue through the end of October 2017.

Great Lakes Watershed Management System (GLWMS)

IWR has made several key enhancements to the GLWMS based upon feedback from key user groups and continued collaboration with The Nature Conservancy (TNC) and Michigan State University Extension (MSU-E). Within the Saginaw Bay Watershed the GLWMS is being utilized by conservation district staff and crop consultants as part of the Regional Conservation Partnership Program (RCPP) to electronically store BMP locations and model anticipated reductions in sediment loading. TNC is coordinating the effort and identified several additions to GLWMS functionality that would assist the RCPP users. IWR accommodated these requests by allowing users to upload BMP locations from their own GIS files and generate sediment modeling results in batch mode, as opposed to individually hand-digitizing each BMP and running sediment models one at a time. This system enhancement allowed the RCPP project to quickly evaluate a large number of prospective BMPs (roughly 1,200 covering almost 38,000 acres) that would have been otherwise impossible given the resources available to the project.

IWR also added the ability to create detailed reports in PDF format, which provided the project with a standardized format to store model results, in addition to a means by which conservation staff or crop consultants could share model results with farmers in situations when internet connectivity might be spotty or nonexistent, such as during a field visit.

In 2016, TNC provided support to IWR to redevelop the GLWMS interface to be more streamlined and provide a plug-in based approach to model development. This new interface provides opportunities to generate customized user work flows to optimize user experience and save time. The plug-in approach has led to new funding to model wind erosion in the coming year.

Train the Trainer - High Impact Targeting (HIT)
In 2012, the US Army Corps of Engineers (USACE) worked with the IWR and Purdue University to develop training materials (e.g., manuals, tutorials, fact sheets, powerpoints and a 10-part video tutorial series) for the High Impact Targeting (HIT) and Long-term Hydrologic Impact Analysis (L-THIA) online systems. These systems were originally developed by the IWR and Purdue University for the USACE Great Lakes Tributary Modeling 516e Program.

This collaboration was an effective and efficient method to further disseminate the online tools throughout the Great Lakes and educate end users. The USACE Buffalo District recently incorporated the train-the-trainer materials into their Sediment Transport Analysis and Regional Training (START) program, launched in early 2015, which offers free trainings to stakeholders across the Great Lakes. They conducted 31 trainings by the end of the 2015 fiscal year and anticipate training 500 individuals in the coming year, demonstrating the far-reaching impact of this initial project.

Sensitive Areas Identification System (SAIS)
The IWR developed a Sensitive Areas Identification System (SAIS) for the USDA Natural Resources Conservation Service, Michigan Office. This system is an online mapping and reporting tool that identifies and maps sensitive areas on farm fields. It is anticipated that this kind of tool may attract new clients to the agency. During the reporting period, a beta-version of the system was developed with input from the Michigan NRCS Office and several farmers. The beta-version assesses a given field's physical characteristics (e.g., soils, slope) and asks users to fill out a brief and optional questionnaire about management practices. Users may generate a report that summarizes potential resource issues (e.g., soil erosion, phosphorus runoff) on a field and describes conservation practices that would help reduce these issues. The tool was released in October 2016 and was presented at the Michigan Association of Conservation Districts conference and shared on the IWR website. The SAIS has been proposed as part of a package of tools for farmers in the 2017 call for proposals from EPA Great Lakes Restoration Initiative funding.

Building a Great Lakes Basin-Wide Networking System

Great Lakes Clean Communities Network (GLCCN) | www.glccn.org
The Great Lakes Clean Communities Network (GLCCN) is a free online network for water, natural resources and environmental professionals working in the Great Lakes Basin, seeking to connect and empower individuals and organizations that strive to make the Great Lakes greater. The Network, funded by the Great Lakes Protection Fund, is a place for practitioners to build new and stronger partnerships, translate innovative ideas into powerful outcomes, and discover game-changing tools and resources.

The online Network provides a space for users to connect with one another through an interactive directory map and group forums. Users are able to explore and add to a database of over 100 interactive tools (e.g., calculators, web-based GIS,

crowdsourcing apps) that address various Great Lakes issues. Through the GLCCN's EcoScore, members can also evaluate and track ecological health in Great Lakes communities.

The Network was released through a soft launch in January 2016. At the end of 2016 there were over 300 registered users with anticipated growth over the coming years.

Members are sharing resources as well as creating and joining groups. The GLCCN is being utilized at the IWR to further disseminate research, decision support tools and other resources to stakeholders across the Great Lakes.

Plans to Disseminate Information from Stated Research

IWR has effectively worked with a variety of organizations and audiences. This has allowed IWR to build a diverse network of partners. As a complicated and wicked problem, effective water resource management requires solutions from the broad economic sectors it affects. With partners from the university, government, non-government, and private sectors, IWR will receive the input needed to reorganize itself as a boundary organization, bridging the gaps between each of the sectors. IWR will work with its partners and internally to co-create solutions to the complex problems posed by water resource management and disseminate this information through its well established technology transfer program, as well as through its decision support systems, regional networking, social networks and facilitation capabilities.
Advisory body inputs will be critically important in defining targets, timelines, and expected impacts. This reorganization can evolve largely within our existing financial and personnel structures. IWRs Advisory Team plays a significant role in helping with dissemination strategies.

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Cooling the Hotspots: Motivating Farmers to Reduce Nutrient Losses

Basic Information

Title:	Cooling the Hotspots: Motivating Farmers to Reduce Nutrient Losses
Project Number:	2016MI238B
Start Date:	3/1/2016
End Date:	2/28/2017
Funding Source:	104B
Congressional District:	8
Research Category:	Social Sciences
Focus Categories:	Non Point Pollution, Water Quality, Conservation
Descriptors:	None
Principal Investigators:	Stephen Gasteyer

Publications

There are no publications.

Title: Cooling the Hotspots: Motivating Farmers to Reduce Nutrient Losses
Project Number: 2016MI238B
Start: 03/1/2016
End: 02/28/2017 (actual)
Funding Source: USGS ("104B")
Congressional District: eighth
Research Category: Social Sciences
Focus Categories: Non Point Pollution, Water Quality, Conservation
Descriptors: Engagement, Non point-source pollution, Runoff, Conservation Practices, Motivations, Communication
Primary PI: Dr. Stephen Gasteyer, Dept of Social Sciences, Michigan State University, East Lansing, MI 48824

Project Class: Research

Problem/Demand

Non point-source pollution from agricultural fields is believed to be the major contributor to hypoxia in the western Lake Erie basin, leading to increasingly severe harmful algal blooms (HABs) in this part of the lake. Specifically in the River Raisin watershed, only a small percentage of farmers and agricultural producers participate in conservation efforts. The ways in which information on conservation practices and programs is spread within the watershed is currently unknown.

Methodology

In order to explore better ways to engage farmers in the River Raisin watershed in conservation efforts, we are working to understand the reasons farmers and agricultural producers get involved in conservation. The research will be conducted through three focus groups and a geo-coded survey distributed within the watershed.

Problem and Research Objectives

The goal is to increase participation in conservation efforts within the watershed, ultimately leading to better water quality in the western Lake Erie basin. The research will help to understand how to spread information more effectively about opportunities to engage in conservation efforts. In turn, this will encourage increased environmental stewardship and a more engaged community.

Project Description: This project will utilize the Pay-for-Performance conservation approach, which was one of the 2014 awardees for a White House and EPA Challenge: Winning Solutions for Nutrient Pollution. Activities include interactions with low-adopting farmers, refinement of hotspot mapping, and installation of BMPs. Outcomes include a reduction in 8,000 pounds of phosphorus, 500 pounds of SRP, 7,300 pounds of nitrogen and 6,800,000 pounds of sediment resulting in an improved drinking water supply, and a reduction in the prevalence of harmful algal blooms in Lake Erie.

Project Location: River Raisin Hydrologic Unit: 04100002; Latitude: 41.889444, Longitude: -84.049022 (coordinates of the city of Adrian, MI located along the South Branch of the River Raisin, the targeted subwatershed in the River Raisin watershed)

Principle Findings and Significance

Accomplishments/Activities (provide bulleted list by task):

Task 2 – Develop & Pilot Pay-for-Performance Conservation

- Completed the integration of the baseline SWAT modeling results into the online Great Lakes Watershed Management System (GLWMS). Users can now access a version of the GLWMS tailored for this project (www.iwr.msu.edu/raisinpfp), digitize field boundaries, and view baseline estimates of phosphorus loading from those fields (as modeled by SWAT).

- As part of a separate project, the GLWMS has gone through a redesign to make the system more flexible and user-friendly. IWR has begun updating the tailored River Raisin version of the site to reflect the new layout, and will redirect users accessing the URL above to this new version once the update is complete.

- Assisted the SWAT modeling team in developing a strategy to translate feedback from the farmer surveys into modeled results that could be accessed through the GLWMS. IWR will help run the large number of SWAT simulations that will cover the possible management scenarios available to farmers within the GLWMS. When those runs are complete, IWR will incorporate the model results into the GLWMS so that users can evaluate various management options in terms of phosphorus load reductions and anticipated incentive payments.

Task 5 – Install, Monitor, and Evaluate BMPs

- Assisted the water sampling group in enrolling four farmers in the monitoring program with Adrian College's lab.

- Collected approximately 25 samples. All data has been stored in Excel and formed into graphs to facilitate visual interpretation.

- This data has been shared with two of the four participating farmers, and they have agreed to continue with sampling for an additional year.

- Because each field being monitored has some form of best management practice that would likely impact the subsurface nutrient loss we are measuring, IWR helped enroll a fifth farmer, not engaging in any of the typical best management practices (other than a filter strip), to serve as a control.

Chemical Monitoring of the River Raisin to Inform Farmers and Optimize Decision Making for BMP Implementation

Basic Information

Title:	Chemical Monitoring of the River Raisin to Inform Farmers and Optimize Decision Making for BMP Implementation
Project Number:	2016MI240B
Start Date:	3/1/2016
End Date:	2/28/2017
Funding Source:	104B
Congressional District:	8
Research Category:	Water Quality
Focus Categories:	Management and Planning, Water Quality, None
Descriptors:	None
Principal Investigators:	James B Martin

Publications

There are no publications.

Title: Chemical Monitoring of the River Raisin to Inform Farmers and Optimize Decision Making for BMP Implementation
Project Number: 2016MI240B
Start: 03/1/2016
End: 02/28/2017 (actual)
Funding Source: USGS ("104B")
Congressional District: eighth
Research Category: Water Quality
Focus Categories: Management and Planning, Water Quality
Descriptors: Watershed Planning and Management; Water Quality
Primary PI: James B. Martin, Associate Professor, Adrian College 110 S Madison St., Adrian, MI 49221, jmartin@adrian.edu

Project Class: Research

Program Introduction

Advances in watershed modelling have enabled researchers to identify "hotspots" within watersheds where waterbodies are particularly vulnerable to high nutrient loading, specifically dissolved reactive phosphorus. This has resulted in increased pressure on farmers in Southeastern Michigan to adopt best management practices through enrollment in government programs. State and federal dollars to fund these programs, however, are limited; and cost-sharing for BMP implementation is competitive. Therefore, it is critical that we focus funding on best management practices that result in the highest possible nutrient loading reductions. We have been able to work towards this with modeling, but farmers remain wary of trusting results using this methodology. This water monitoring program aims to help bridge our gap in understanding of BMP effectiveness, while providing farmers with data they are more willing to trust.

Problem/Demand

Currently, little water quality data exists (other than at the mouth of the river) for the purpose of helping farmers make informed decisions regarding best management practice implementation in the River Raisin Watershed. Farmers need further information, in the form of observable data, concerning nutrient loading to increase interest in BMPs.

Methodology

The Michigan State University (MSU) Institute of Water Research (IWR) will collaborate with both the River Raisin Watershed Council (RRWC) and Adrian College. Adrian College will provide a team of undergraduate students to perform the sampling while under the supervision of biology professor – Dr. Jim Martin. Sampling team will collect 500 mL from each tile drain weekly. Chemical analysis will be done in a lab at Adrian College. Parameters measured will include PO4-P and NO3-N, and flow rate will be determined on site. All chemical tests will be

run in accordance to standard test methods using a Hach DR6000 Spectrophotometer with quality control checks in place. Data will be stored in an Excel spreadsheet, as well as in a laboratory notebook.

Problem and Research Objectives

Objectives

Objective A:

The Phase I overall objective is to attend farmer's advisory committee meetings (FAC) and contact landowners within the River Raisin Watershed and obtain a list of candidates who are interested in participating in this study.

Objective B:

The Phase II overall objective is to perform chemical sampling from participating farms tile drains over a six-month period.

Objective C:

The Phase III overall objective is to make data available to farmers and discuss the data collected during FAC meetings to determine whether the data was useful to them, or peaked their interest in BMP adoption.

Principle Findings and Significance

Over a 12-month period (June 2016 – May 2017), 20 water samples have been collected from six tile drains. The nutrient concentrations have been organized into graphs which clearly demonstrate changes in concentration throughout the year. Obvious correlations with farm management practices can be seen in the NO3-N data; phosphorus data, however, remains difficult to interpret. Flow data was limited to one weekly reading, but this information was used to gain a general understanding of weekly nutrient loading rates throughout the year. As mentioned previously, noticeable differences could be seen between farms regarding concentrations of nitrate; but causes for those differences are still under interpretation. Each participating farmer has reviewed their water quality data during one-on-one meetings, and each has agreed to continue with sampling for another year. Farmers are interested in the results, but would like to see how they change once they put in a new crop. At this time, no participating farmers have agreed to change management practices, but are willing to revisit the discussion after they've seen another year's worth of data. Water sampling is scheduled to continue until June of 2018. Data will be organized into a final report where suggestions will be made for types of farm management that result in lower concentrations of PO4-P and NO3-N; especially during early spring months when waterways are most vulnerable to high nutrient loading.

Saginaw River Sedimentation Study SWAT Modeling in the Saginaw River Watershed

Basic Information

Title:	Saginaw River Sedimentation Study SWAT Modeling in the Saginaw River Watershed
Project Number:	2016MI247S
USGS Grant Number:	
Sponsoring Agency:	Army Corps of Engineers
Start Date:	2/3/2016
End Date:	2/6/2017
Funding Source:	104S
Congressional District:	8
Research Category:	Water Quality
Focus Categories:	Models, Sediments, Surface Water
Descriptors:	None
Principal Investigators:	Amirpouyan Nejadhashemi

Publication

1. Daneshvar, F., A.P. Nejadhashemi, U. Adhikari, B. Elahi, M. Abouali, M.R. Herman, E. Martinez-Martinez, T.J. Calappi, B.G. Rohn, 2017. Evaluating the Significance of Wetland Restoration Scenarios on Phosphorus Removal. Journal of Environmental Management, 192, 184-196.

Title: Saginaw River Sedimentation Study SWAT Modeling in the Saginaw River Watershed
Project Number: 2016MI247S
Start: 03/1/2015
End: 02/29/2017 (actual)
Funding Source: USGS ("104B")
Congressional District: eighth
Research Category: Water Quality
Focus Categories: Surface Water, Sediment, Models
Descriptors: GLRI, Saginaw River, SWAT, Modeling
Primary PI: Amirpouyan Nejadhashemi, Associate Professor, Farrall Hall, East Lansing, MI 48824, pouyan@msu.edu

Project Class: Research

General Statement

The Great Lakes Restoration Initiative was launched in 2010 to accelerate efforts to protect and restore the largest system of fresh surface water in the world — to provide additional resources to make progress toward the most critical long-term goals for this important ecosystem.

Problem/Demand

The overall goal of this study is to develop a comprehensive understanding, from source to sink, of total phosphorous and sediment within the Saginaw River Watershed and to determine the effectiveness of the sediment and nutrient management practices implemented through the Great Lakes Restoration Initiative (GLRI).

Methodology

The focus of this study is to analyze the projected phosphorus and sediment reductions from GLRI funded projects. Total phosphorous and sediment loadings before, during, and after GLRI-funded projects have been implemented in the watershed will be examined. We proposed to use the Soil and Water Assessment Tool (SWAT) to model phosphorus and sediment loadings within the watershed. SWAT is suited for long-term and large-scale modeling of river basins, and it is an appropriate model for determining nutrient and sediment loads within the watershed.

Problem and Research Objectives

Upon completion of the project, four major tasks will be accomplished as follows: 1) Data review and analysis, 2) Nutrient and sediment modeling, 3) Model application for GLRI metrics, 4) Preparation of the final report.

Concerning Task 1, available relevant flow, nutrient, and sediment data were obtained and prepared for SWAT model input, calibration, and validation purposes. In addition, an inventory of implemented GLRI-funded best management practices within the Saginaw River Watershed was obtained from the Natural Resources Conservation Service

Concerning Task 2, the SWAT model was setup for the Saginaw River Watershed, the model was calibrated to ensure the model appropriately represents the behavior of tributaries in the physical world. Calibration was completed by running the SWAT model and comparing the results to

previously observed values. We also examined the effectiveness of wetland implementation scenarios.

Principle Findings and Significance

The SWAT model was setup for the study area using both physiographical (e.g. elevation, landuse, and soil type) and climatological (e.g. precipitation and temperature) data. The calibrated SWAT model was run for 10 years to simulate flow, sediment fractions (sand, silt, and clay), and phosphorus loads for each stream segment within the study area. Overall, the performance of 2 ha wetlands in total phosphorus reduction was significantly lower than the larger sizes at both the subwatershed and watershed levels. Regarding wetland implementation sites, wetlands located in headwaters and downstream had significantly higher phosphorus reduction than the ones located in the middle of the watershed. More specifically, wetlands implemented at distances ranging from 200 to 250 km and 50 to100 km from the outlet had the highest impact on phosphorus reduction at the subwatershed and watershed levels, respectively.

Publications

1. Daneshvar, F., **A.P. Nejadhashemi**, U. Adhikari, B. Elahi, M. Abouali, M.R. Herman, E. Martinez-Martinez, T.J. Calappi, B.G. Rohn, 2017. Evaluating the Significance of Wetland Restoration Scenarios on Phosphorus Removal. *Journal of Environmental Management*, 192, 184-196.

Information Transfer Program Introduction

Program Introduction The state of Michigan has an abundant and widespread supply of water due in large part to its geographical location within the Upper Great Lakes Region. The state's many rivers, lakes, and wetlands as well as the Great Lakes support critical habitat, a world class fisheries, and high quality waters. Citizens within the state and region utilize these resources for drinking water, recreation, industrial processes, irrigation, and numerous other activities. As these uses continue to grow, these waters become more susceptible to degradation, ecosystem changes, and may result in conflicts among water users. Problems associated with phosphorus and nitrogen runoff, storm water, invasive species, habitat degradation, climate change, and wetland loss are just a few of the many challenges that Michigan residents and decision makers face. Additionally, water withdrawals from both surface water and groundwater for irrigation or other water uses can result in decreased stream flow or reduced lake levels and lead to ecological and human-related problems. Conflicts between irrigators and domestic users may also increase as withdrawals affect well water. These issues are exceedingly complex and sometimes contentious. They require people working together and having access to reliable data, human resources, and good science-based knowledge of the situations.

Technology Transfer Training, Dissemination and Program Development

Basic Information

Title:	Technology Transfer Training, Dissemination and Program Development
Project Number:	2016MI237B
Start Date:	3/1/2016
End Date:	2/28/2017
Funding Source:	104B
Congressional District:	8
Research Category:	Water Quality
Focus Categories:	Surface Water, Water Quality, Education
Descriptors:	None
Principal Investigators:	Lois Wolfson

Publications

1. Kline-Robach, Ruth, Lois Wolfson, Susan Masten, Darren Bagley, Terry Gibb, and Bindu Bhakta. 2017. A Guide to Home Water Treatment. MSU Extension Bulletin Series, E3342; Michigan State University, East Lansing, MI. 8 pp.
2. Koundinya, Vikram, Anne Baird, Jenna Klink, Lois Wolfson, Jane Frankenberger, Joseph Bonnell, and Rebecca Power. Submitted. Core Competencies for Successful Watershed Management Work. Journal of Extension
3. DePalma-Dow, A., Wolfson, L. G., Elgin, E. L., and Throckmorton, E. (2016). Water Quality and Aquatic Plant Assessment: Fremont Lake Final Report. Michigan State University, East Lansing, MI
4. Wolfson, Lois. 2016. The Effects of a Warm Winter on the Ecology of our Inland Lakes. Oakland Lakefront Lifestyles, Vol. 24 (2): 18-19.
5. Bagley, Darren, Ruth Kline-Robach, Lois Wolfson, Terry Gibb and Bindu Bhakta. 2016. Water filters and lead: Minimize your exposure to lead in drinking water by the using filters. Michigan State University Extension News, Michigan State University, East Lansing, MI
6. Bagley, Darren, Ruth Kline-Robach, Lois Wolfson, Terry Gibb and Bindu Bhakta. 2016. Whole house water treatment systems and the Flint water crisis. Michigan State University Extension News, Michigan State University, East Lansing, MI
7. Bhakta, B. R., Ruth Kline-Robach, Lois Wolfson, Terry Gibb & Darren Bagley 2016. Testing drinking water for lead in homes. MSU Extension News, Michigan State University, East Lansing, MI

Title: Technology Transfer Training, Dissemination and Program Development
Project Number: 2016MI237B
Start: 03/1/2016
End: 02/28/2017 (actual)
Funding Source: USGS ("104B")
Congressional District: eighth
Research Category: Water Quality
Focus Categories: Surface Water, Water Quality, Education
Descriptors: Great Lakes, Inland Lakes, Watershed Management; Climate Change; Invasive Species; Online Education; Interactive Web-based Systems
Primary PI: Dr. Lois G. Wolfson, Outreach Specialist, Michigan State University, East Lansing, MI 48823

Project Class: Information Transfer

General Statement

Problem/Demand

Water is a shared resource which people depend upon for a multitude of activities such as drinking, manufacturing, irrigation, recreation, energy, tourism, food, and ecosystem health. Michigan is a water-rich state with over 11,000 inland lakes greater than 5 acres in size, 36,000 miles of river and streams, 5.5 million acres of wetlands, a vast and accessible groundwater supply, and 20% of the world's freshwater surface supply within the surrounding Great Lakes. Yet, the huge demand and multiple uses of water by citizens of the state often result in degradation, ecosystem changes, and water use conflicts, particularly during times when water demands are at their peak level. As long as water uses within the state continue to increase, they become more at risk. Understanding potential impacts that may occur from land use activities, erosion, nonpoint source pollution, and climate change, and having the knowledge and resources to make good decisions regarding these impacts is essential for long term sustainability of the state's water resources.

Methodology

Effective dissemination of information, interaction with stakeholders, and data access must be timely, accurate, unbiased and research based. An overall program that is proactive and responsive to the needs of Michigan citizens helps assure that problems relating to water quality and availability are being addressed in a timely manner. Many modes of information exchange have been used to enhance this program, reach new audiences and develop new initiatives through partnering and collaborating with multiple user groups. Based on past formats and their evaluation, the mechanisms for this project included: (1) developing, organizing and co-coordinating technical and non-technical conferences that addressed current and emerging water related issues; (2) developing training sessions, workshops and webinars that helped users understand aquatic ecosystems and water quality issues; (3) creating and delivering lectures, demonstrations and power point presentations to varied audiences; (4) developing web-based interactive programs that utilized new technologies to assess and address potential problems and inform users to help with their decision making

and capacity building; (5) compiling, interpreting, and distributing water related information to multiple user groups throughout the state; (6) partnering with MSU Extension field and campus educators to coordinate and support programs at the local level and 7) interacting and coordinating efforts with researchers, agency personnel, other states, and professionals on multidisciplinary issues related to water issues.

Problem and Research Objectives

The objectives of this program address the problems and issues relating to both water quality and water availability and include: 1) development and presentation of educational programs designed to increase the public's awareness, knowledge and appreciation and action of the water quality and quantity problems in Michigan; 2) incorporation of new developments and issues relating to water into existing and new programs; 3) development of hands-on tools and models to address environmental and economic complexities required to solve real world water related problems; 4) addressing high priority and emerging issues; 5) evaluation of the projects disseminated and incorporating lessons learned into new programs; 6) development of programs in a variety of formats that meet the needs of individuals and user groups; and 7) coordination and development of multidisciplinary projects in a co-creative process with both clientele and associates, including extension educators, faculty on campus, other agencies, environmental organizations, and other Universities in order to make water-related information readily usable and available to clientele, collaborators, and partners across the state.

Principal Findings and Significance

Conferences

FY 2016 marked the 26th year for the annual Great Lakes conference. The conference, “The Great Lakes: Michigan’s Water Heritage” focused on Michigan’s new 30-year Water Strategy developed by the State’s Office of the Great Lakes and featured presentations related to goals of the strategy. This year, 240 people registered for the conference. Based on the evaluations returned (~25%), 93% ranked the conference as excellent or very good. When asked what the most valuable aspect of the conference was, comments included: “very informational”; up to date information”; “variety of topics“; speakers were well-prepared and engaging”; knowing so many people are working to keep water quality up”; and educational/teacher resources”. Many indicated that they had attended the Great Lakes conference in the past, were involved with some aspect of the Great Lakes, either through their work or through teaching, and that they will use the information gained from this conference in their current work. Partners with the Institute for this conference were Michigan Sea Grant Extension, MSU Department of Fisheries and Wildlife, and the Office of the Great Lakes, Michigan Department of Environmental Quality (MDEQ).

The 2nd biennial Michigan Inland Lakes Convention drew close to 300 people during its three day venue. The Convention focused on Science and Leadership, and provided a plenary session with two keynote speakers, 18 concurrent presentations, 10 workshops, over 25 exhibitors, and a field trip. An evaluation of the program found that over 90% of responders felt the convention provided useful information, had knowledgeable presenters, met their expectations, and was a good use of their time. They also indicated that they had gained

information that will assist them in their jobs, that they learned something new that they plan to share with others, and that the convention increased their lake leadership skills. Attendees represented riparian property owners, non-profit organizations, state and federal agencies, businesses, University, tribal, and city government. Developers of the Convention included the Michigan Departments of Environmental Quality and Natural Resources, MSU-IWR, MSU Extension, and three of the key nonprofit lake and stream organizations in the state.

The North Central Region Water Network's conference, "From Science to Success: Bridging the Gap between Knowledge and Practice in Water Resource Management" was co-sponsored by the land grant universities in the North Central Region, including IWR-MSU. Held in Lincoln, NE, the conference helped to increase awareness of water-related issues, research and Extension programs that provide benefits across the North Central Region, and strengthen professional networks. Each of the states shared data and information on key water issues and coordinated efforts in writing future proposals. Of the topics presented, participants felt the conference expanded their awareness most in nutrient and manure management and soil erosion. When asked how their networking experience at the conference may affect future collaboration responses included increased collaboration in creating educational materials, increased regional efforts, and sharing of resources on topics such as storm water and severe weather events. Approximately 125 people attended the networking conference.

Online Courses and Webinars

Introduction to Lakes Course: This six week course presented online offered narrated power point presentations, interactive discussions, and live Q&A sessions on six main topics: General Lake Ecology, Watersheds, Natural Shorelines, Michigan Law, Aquatic Plants, and Citizen Involvement. Of the 152 students registered, 137 completed the course. Of those completing the evaluations, 69% plan to share what they learned with their neighbors and other community members; 68% plan to volunteer and be more engaged; and 54% plan to get involved with water monitoring. In addition, students who completed the course were eligible to receive credits offered for Pesticide Applicator Recertification (Commercial Core or Category 5 [Aquatics]); Michigan Department of Education for State Continuing Education Clock Hours; and MSU Extension Master Citizen Planner.

Climate Change Webinar Series: As part of MSU's Climate Outreach team, IWR took the lead in the development of an online course to provide Extension educator with five modules on Climate Science Basics; Impacts; Knowns and Unknowns; Attitudes on Climate Change; and a Summary and Relevance to the MSU Extension Institutes. The course was put online in October. Only a handful of participants have signed up to take the course. The outreach team is currently determining how to engage more educators to take the course.

Watershed Courses: The four modules that make up the Online Certificate in Watershed Management course were modified and updated to reflect new information on various issues and be more relevant to today's problems and current trends. Classes can be taken for academic credit or for certification of completion. Both MSU students and practitioners took one or more of the courses this year. A video that discusses the course offerings was produced by students in a MSU Social Sciences Information Technology class and was

added to the web site. The course is offered through the MSU Department of Community Sustainability with IWR staff leading the class.

Web Based Tools
The IWR developed a new decision support tool and continued working and updating several other ones. The new system, *Water Ways*, was developed with external funding that reports hydrologic outputs from a diverse set of models, under multiple future climate scenarios. The program was aimed to help agricultural producers and water resource policy-makers and managers develop sustainable water strategies for their operations, their communities, and ecosystems. The program provides an individualized report to users at a sub-watershed scale and is being used in the southwest part of the state. Work continued on updating and improving the Great Lakes Watershed Management System, an online tool for evaluating, tracking, and reporting water quality and groundwater recharge improvements at the watershed and field scales. The system allows users to evaluate impacts on groundwater recharge levels and sediment and nutrient loading, based on changes in land cover or management. The output from the tools are now being used in two watersheds in southeast Michigan (River Raisin) and Saginaw Bay in a "Pay for Performance" program for farmers.

The IWR revamped its web site to make it easier for users to navigate and find the information they need. It includes all of the online tools developed at the IWR (networking decision support and watershed analysis), information on the online courses, USGS research funded projects, initiatives and engagement, upcoming conferences and workshops, and campus-wide events. The web site also includes its on-line newsletter, *The Watershed Post*. Contributions are made by IWR faculty, staff, and students.

Trainings/Workshops
Several lake ecology workshops as well as a workshop on a Water School for Local Officials were presented. One lake workshops was part of the Conservation Stewards program, with approximately 22 participants. The other class was held in conjunction with Oakland county parks with about 30 attendees. Both classes featured experiential learning on aquatic plants, water testing, and current information on invasive species that threaten lakes. Evaluations indicated that participants found the classes valuable. The Water School program with topics on water quantity, water quality, economics, and policy was launched in November with an audience of Sea Grant educators, the Office of the Great Lakes, a drain commissioner, a few planners, watershed council members, and a few local officials. Their input into the program provided valuable feedback that was used in further developing the School for its major roll out, scheduled in 2017.

As part of an outside grant, IWR was contracted to take part in a lake study and provide findings and recommendations to the city and township. Three workshops were held over the course of the summer with over 50 people at each session. One respondent said, "It's gratifying to note that Fremont Lake is improving and that there are some immediate steps we can implement to continue efforts to improve the lake."

Programming with Partner Organizations
As a member of several statewide partnerships including the Michigan Natural Shoreline

Partnership; Michigan Chapter, North American Lake Management Society (McNALMS), and the Michigan Inland Lakes Partnership, IWR staff worked with these groups in various capacities to offer several programs. In addition to the Michigan Inland Lakes Convention (discussed above), a Shoreline Recognition Program for lake property owners across the state was rolled out and IWR staff helped in the program survey. In year one, 20 lake associations representing 50 lakes registered. Over 400 people took the online questionnaire which resulted in 350 people achieving Shoreline Steward Status. The Student Research Grant Program, offered through McNALMS and chaired by IWR staff, awarded two student grants, one for research on phosphorus retention in two-stage ditches and one on assessing cyanobacteria to suppress growth and development of dreissenid larvae.

Exhibits and Demonstrations

The IWR took part in a variety of University sponsored events, and provided programs that showcased the University's and IWR's role in science based education. For the annual MSU Science Festival, the IWR featured an exhibit on groundwater movement and potential contamination. The event then had participants create their own "edible aquifers" as a hands-on learning exercise. Three classes were held with a total of 36 students and adults per class. The event is being recognized as a Featured Event for the 2017 Science Festival. Two classes were taught during MSU Grandparents' University on streams and water quality. Both classes reached capacity (30 students per class). An exhibit featuring Watersheds was held during the MSU Autumn Fest with over 500 people visiting the exhibit and interacting with IWR staff.

Lectures and Seminars

Lectures for students on campus as well as participating in conferences and seminars were given by IWR staff members throughout the year. Key topics included aquatic invasive species, storm water practices, stream monitoring, lake management, phosphorus runoff and use of decision support tools. Audience or class participation ranged from approximately 25 to over 100 for each presentation.

Notable Achievements

The Introduction to Lakes online program received two awards in 2016: the Distinguished Team Award from the Michigan Alpha Psi Chapter of Epsilon Sigma Phi and the 2016 Innovative Program Award from the Community and Natural Resources Development Association at Michigan State University

The Michigan Chapter, North American Lake Management Society awarded its 2016 Lifetime Achievement Award to Dr. Lois Wolfson, Senior Specialist at IWR.

Publications

2016-2017

Kline-Robach, Ruth, Lois Wolfson, Susan Masten, Darren Bagley, Terry Gibb, and Bindu Bhakta. 2017. A Guide to Home Water Treatment. MSU Extension Bulletin Series, E3342; Michigan State University, East Lansing, MI. 8 pp.

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DePalma-Dow, A., Wolfson, L. G., Elgin, E. L., and Throckmorton, E. (2016). Water Quality and Aquatic Plant Assessment: Fremont Lake Final Report. Michigan State University, East Lansing, MI

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Wolfson, Lois and Jane Herbert. 2013. A Michigan Boater's Guide to Selected Invasive Aquatic Plants. MSU Extension Bulletin E-3189. Michigan State University, East Lansing, MI. 28pp.

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Creation of Water Resource and Watershed Management-related Short Courses for use by Organizations offering Continuing Education Credits

Basic Information

Title:	Creation of Water Resource and Watershed Management-related Short Courses for use by Organizations offering Continuing Education Credits
Project Number:	2016MI239B
Start Date:	3/1/2016
End Date:	2/28/2017
Funding Source:	104B
Congressional District:	8
Research Category:	Social Sciences
Focus Categories:	Education, Law, Institutions, and Policy, Water Quality
Descriptors:	None
Principal Investigators:	Saichon Seedang, James O Duncan, Jerry Harte

Publications

1. MWEA Class 1. 2016. Basic Hydrology for Watershed Management. https://d2l.msu.edu/d2l/home/524649
2. MWEA Class 2. 2016. Addressing Water Quality. https://d2l.msu.edu/d2l/home/524651
3. MWEA Class 3. 2016. Socioeconomic, Institutions and Management Issues. https://d2l.msu.edu/d2l/home/524653
4. MWEA Class 4. 2016. Developing and Implementing Watershed Management Plans. https://d2l.msu.edu/d2l/home/524655
5. MWEA Class 5. 2016. Tools Used in Watershed Management. https://d2l.msu.edu/d2l/home/524657
6. MWEA Class 6. 2016. Soil Erosion & Sedimentation and Pollution. https://d2l.msu.edu/d2l/home/524659
7. MWEA Class 7. 2016. Historical & Legal Issues of Watershed Management. https://d2l.msu.edu/d2l/home/524661

Title: Creation of Water Resource and Watershed Management-related Short Courses for use by Organizations offering Continuing Education Credits
Project Number: 2016MI239B
Start: 03/1/2016
End: 02/28/2017 (actual)
Funding Source: USGS ("104B")
Congressional District: eighth
Research Category: Social Sciences
Focus Categories: Education, Law, Institutions, and Policy, Water Quality
Descriptors: Water resources, Watershed, Management, Courses, Continuing education
Primary PI: Jerry Harte, Michigan Water Environment Association, (MWEA), East Lansing, MI 48823, , James Duncan, Institute of Water Research, Michigan State University, East Lansing, MI 48823, duncan37@msu.edu

Project Class: Research

Program Introduction

Problem/Demand

Problem A goal of the Institute of Water Research (IWR) at Michigan State University (MSU) is to continually find outlets by which it can share its research findings and data, and the tools it has developed, with people so they can better understand and manage water resources. The need for this is continually acute given the importance of water resources to Michigan and the Great Lakes region, and the scarcity of water in areas of the United States and world. The need for reliable and sustainable sources of water is increasingly critical to agriculture as it is faced with feeding the world population projected to increase from 7 to 9 billion people by the mid-21st century.

Once avenue through which IWR informs others of water resource issues and strategies by which to manage them is through the four online courses it developed that constitute its Certificate in Watershed Management program (WMC). Created in the early 2000s, the courses provide students with information about water resources and contemporary strategies by which to manage them. Successful completion of the courses earns the student a Certificate in Watershed Management awarded by IWR.

Unfortunately, enrollment in the WMC program has waned, declining from a high of 14 certificates awarded in 2004 to 3 certificates awarded during since 2013. IWR staff attribute this decline to a general lack of promoting the courses and certificate program, and to changes staff turnover. After stabilizing staffing, IWR developed marketing brochures and a video to help promote the WMC program, and began reaching out to partner organizations to gain their endorsement. During the meetings with the first partner approached, the Michigan Water Environment Association (MWEA), concern over the method of course delivery was raised. While the courses are relevant and current, their semester-based method of delivery may no longer be suited for the schedules of contemporary students (typically post-graduate working professionals). Since many professional organizations require their members obtain ongoing

education to retain professional certification, tapering the courses to make them available for continuing education units would serve these working students more practically and beneficially, thereby broadening their appeal and educating more people about watershed management.

Methodology

Methods Content in each of the four courses will be condensed into shorter courses by IWR. Each short course will contain the course material found in the current courses but offered over a shorter time frame and each short course will have fewer assessment requirements. Short course delivery will be made available 24/7/365 (rather than semester-only). MWEA will assign continuing education credits to the short courses, which will be available to its membership at their discretion toward attainment of a MWEA water professional certificate. (Note: the semester-based courses and WMC will continue to be offered.)

Problem and Research Objectives

Objectives Providing shorter, more focused courses, integrated into certificate programs offered by water resource related professional organizations, will make the courses appeal and be available to a wider audience, thereby providing education about watershed management and related topics to more people.

Principle Findings and Significance

Since March 1, 2016, the goal of IWR staff was to review the 4 semester-based courses that comprise its Watershed Management Certificate program and condense the material contained therein into 7 shorter classes. Each class was intended to take a student 30 hours to complete, after which a short quiz would be administered by IWR. Simultaneously, the goal of MWEA staff was to develop a certificate program of their own, viewing it as a benefit for their membership, for which (at least some) the material would be the new IWR classes. A second goal of MWEA was to redesign their website, through which their certificate program (and IWR classes) would be advertised and promoted.

In addition to meeting internally to accomplish their respective goals, IWR and MWEA staff met jointly throughout the grant year to measure and report progress, to review the content and structure of the new classes being developed, to review the requirements of the MWEA certificate program, and to develop the process by which students would navigate the MWEA certificate program through MWEA and IWR. To help guide each organization, a Memorandum of Understanding signed by both parties that outlines their responsibilities and expectations.

As of February 28, 2017, the MWEA website was fully functional, and the MWEA certificate program structure and requirements were established. Aside from typical and ongoing content updating, the 7 classes were fundamentally completed by IWR and made available to MWEA staff to review. MWEA set the date to launch their certificate program (newly named Watershed Management Certificate program) to coincide with their annual Watershed Summit to be held on March 29, 2017.

USGS Summer Intern Program

None.

Student Support					
Category	**Section 104 Base Grant**	**Section 104 NCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	0	0	0	0	0
Masters	2	0	0	0	2
Ph.D.	4	0	0	0	4
Post-Doc.	0	0	0	0	0
Total	6	0	0	0	6

Notable Awards and Achievements